New term for effect of temperature on pHMIN–values in cardinal parameter growth models for Listeria monocytogenes

Martinez Rios, Veronica; Dalgaard, Paw

Publication date:
2018

Document Version
Peer reviewed version

NEW TERM FOR EFFECT OF TEMPERATURE ON pH_{MIN}–VALUES IN CARDINAL PARAMETER GROWTH MODELS FOR *LISTERIA MONOCYTOGENES*

Veronica Martinez-Rios, Paw Dalgaard

National Food Institute (DTU Food) Technical University of Denmark, Kemitorvet building 204, DK-2800 Kgs. Lyngby, Denmark

Cardinal parameter models for growth and growth boundary of *L. monocytogenes* (CPM-*Lm*) are popular, extensively validated and widely used for various foods in the assessment and management of risk. Interestingly, available CPM-*Lm* includes very different pH_{min}-values from 4.3 to 5.0. This can be due to differences in the mathematical terns used to estimate pH_{min}-values and to strain variability as often suggested. However, the experimental conditions used to estimate pH_{min}-values remain little studied although the minimal pH-values supporting growth is known to depend on other environmental conditions including temperature. Therefore, the objective was to study the influence of temperature on pH_{min}-values of *L. monocytogenes* as used in CPM-Lm.

The combined effect of temperature and pH on maximum specific growth rate (μ_{max}) for eight different *L. monocytogenes* strains were determined experimentally by using Bioscreen C or collected from the literature (287 μ_{max}–values). 16 pH-values from 4.4 to 6.8 and eight temperatures from 5°C to 37°C were studied. At each temperature the pH_{min}-value was estimated by fitting a simple pH_{min}-model (AEM, 63, 2355-2360, 1997). pH_{min}-values decreased from 5.0 at 5°C to 4.3 at 20°C and then increased to 4.7 at 37°C. These changes in pH_{min}-values has major influence on predictions from CPM-*Lm*, particularly for products with low pH values of less than about 5 and a new pH_{min}-model to describe the influence of temperature on pH_{min}-values in CPM-*Lm* was developed as shown below.

$$0°C \leq T < T_{ref} \qquad pH_{minT} = pH_{min0} - T * \left(\frac{pH_{min0} - pH_{minR}}{T_{ref}}\right)$$

$$T_{ref} < T < 37°C \qquad pH_{minT} = pH_{minR} + \left(T - T_{ref}\right) * \left(\frac{pH_{min37°C} - pH_{minR}}{37 - T_{ref}}\right)$$

where T is the storage temperature (°C); pH_{minT} the fitted pH_{min}–value at T°C; T_{ref} the estimated reference temperature (°C); pH_{min0} and pH_{minR} the fitted pH_{min}–values at 0°C and T_{ref} (°C), respectively.

The fixed pH_{min}-value from an existing CPM-*Lm* including 12 environmental parameters (IJFM, 141, 137-150, 2010) was substituted by the new pH_{min}-model and the model performance has been evaluated for 33 growth/no growth responses of *L. monocytogenes* in a well characterized food with pH below 5.

Average bias and accuracy factor values were 1.16 and 1.27 for 30 growth curves at constant temperatures. The new pH_{min}-model can estimate the pH_{min}-value for *L. monocytogenes* based on temperature storage conditions and this markedly extend the limit of applicability of the existing CPM-*Lm* from pH 5.6 to pH 4.4.